

Towards an Antarctic Ice Shelf and Glacier Front Monitoring Service based on Sentinel-1 Data

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Introduction

The German Aerospace Center (DLR) is currently facilitating a project aiming to bring together the expertise in polar research: The Polar Monitor Project. Within this project, we are establishing an automated calving front monitoring service providing monthly **Ice Shelf and Glacier Front Time Series** (IceLines) via the EOC GeoService hosted by DLR. IceLines is based on a deep learning architecture optimized for calving front extraction by combining segmentation and edge detection techniques.

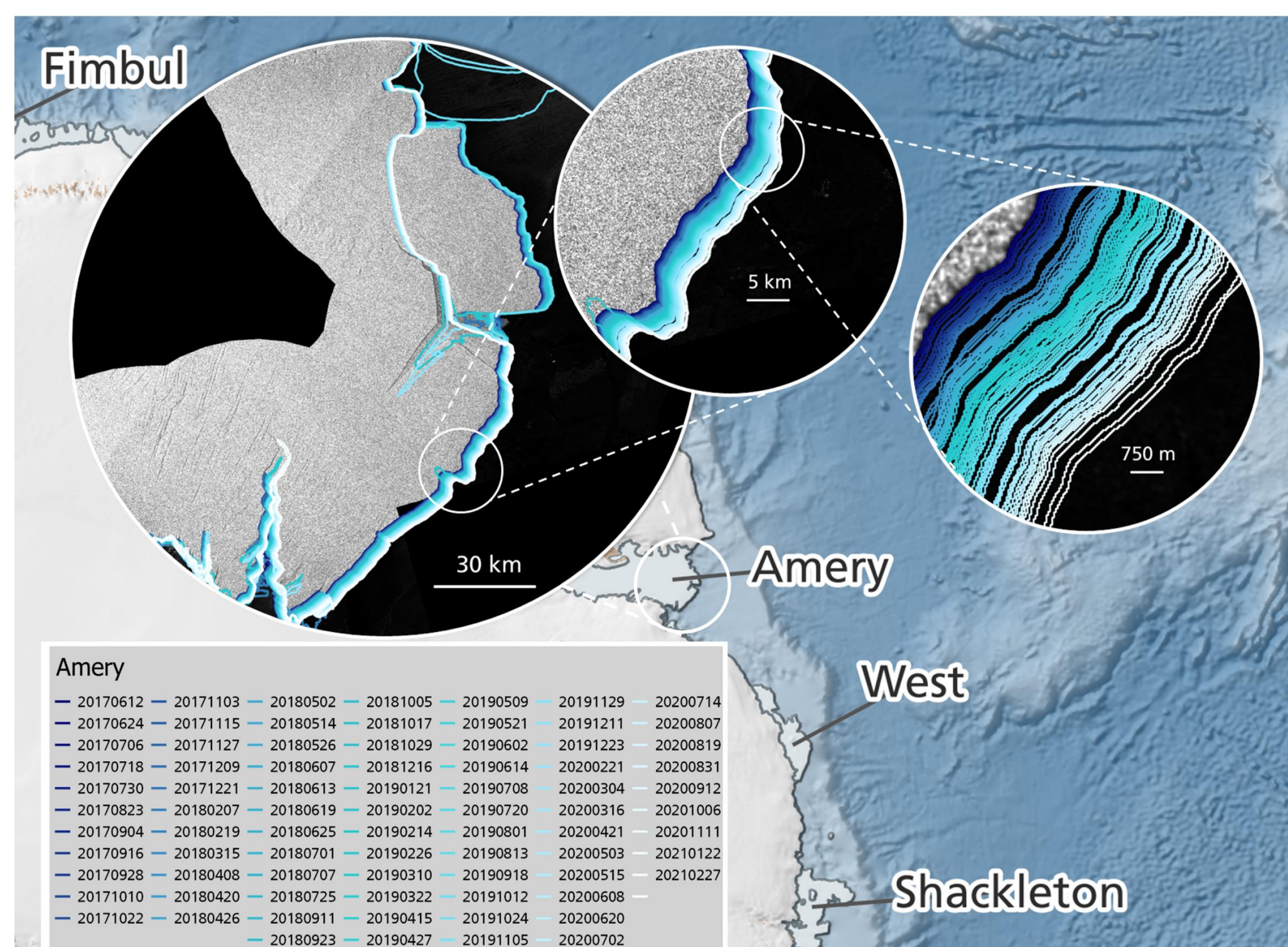


Figure 1: Detailed calving front location time series of Amery Ice Shelf between 2017 and 2021 derived from Sentinel-1 data. © Copernicus Sentinel-1 Data 2021.

Calving Front Extraction

Calving fronts are extracted with HED-Unet. This is a deep learning (DL) architecture designed for edge detection and segmentation. A hierarchical attention mechanism is implemented to use the information available at all different resolution levels.

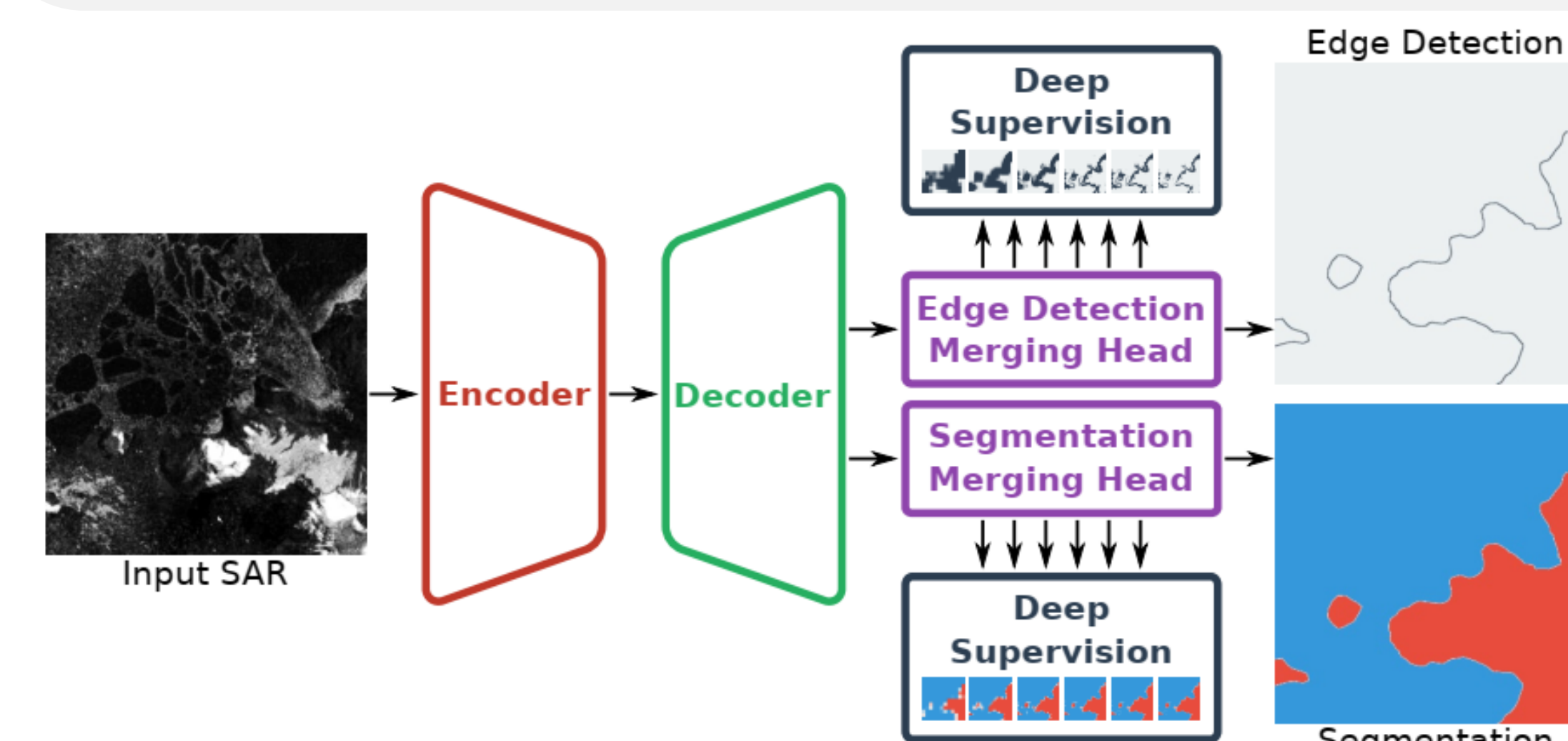


Figure 2: HED-Unet architecture combining segmentation and edge detection to extract the calving front location. Heidler et al. 2021, IEEE TGRS

Implementation

The ice shelf and glacier front monitoring service is implemented within the DLR IT-Infrastructure. Sentinel-1 scenes are automatically provided by the Internal Data Access (IDA) over the selected monitoring sites. The data is transferred to the HDFS (Hadoop Distributed File System), a data

storage system to allow for high-performance processing of large data sets. The SAR pre-processing is performed on a Hadoop Cluster. For the DL-based calving front extraction, a GPU cluster is used. The applications run automatically within Docker containers. For automated monthly updates, the extracted fronts are transferred to the GeoService pick-up point.

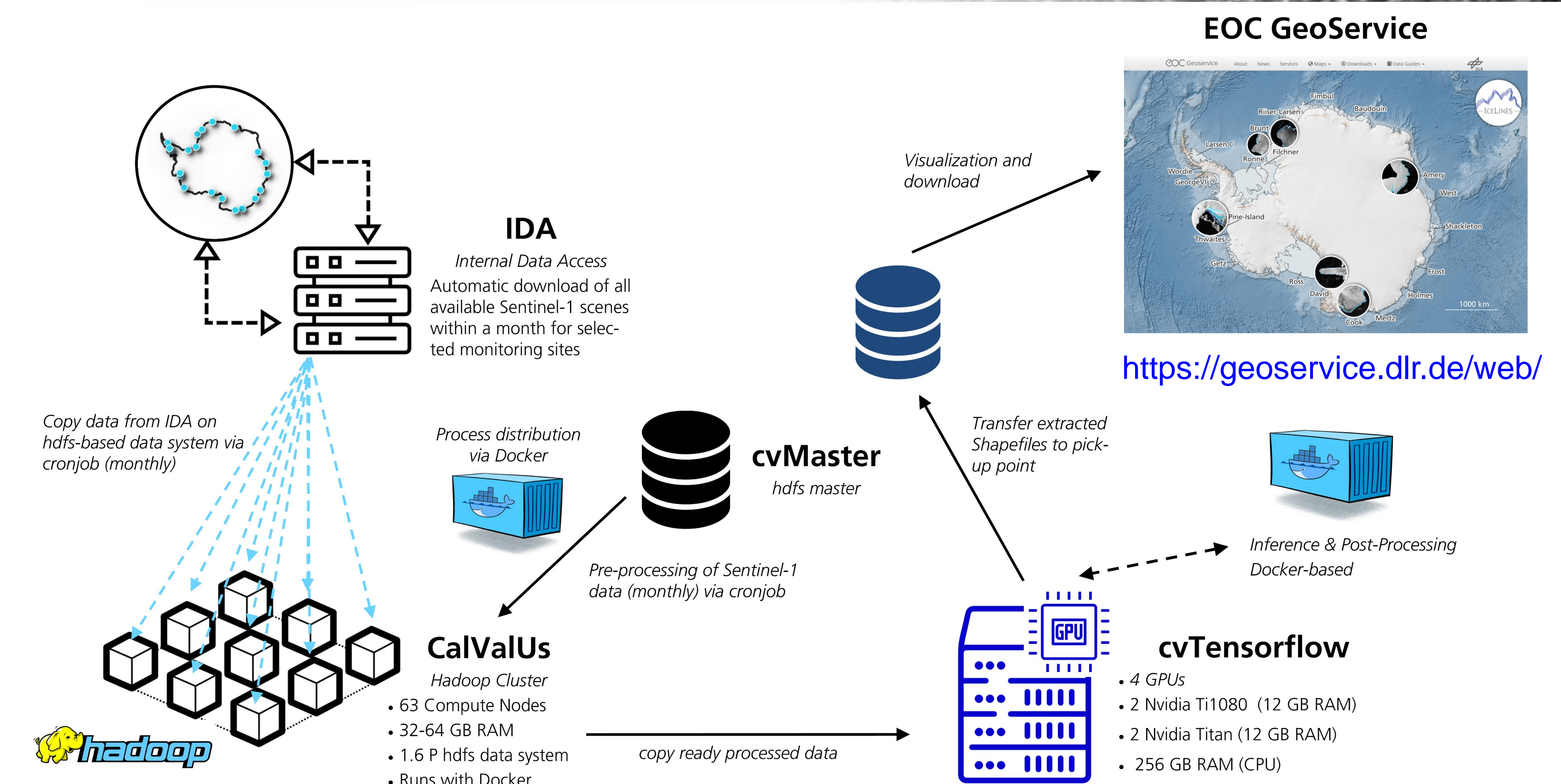


Figure 3: Implementation of IceLines within the DLR IT-Infrastructure designed for near-real-time monitoring of Antarctic glacier and ice shelf fronts.

Available Products

IceLines will provide near-real-time monthly calving front positions for approx. 20 selected Antarctic ice shelves and glaciers. The front positions are provided by the EOC Geoservice (geoservice.dlr.de) for data discovery, visualization and download. The IceLines products

will include calving front positions on a monthly, quarterly and annual basis as well as the Antarctic coastline. Currently, the time series covers a time span from 2017 to today but will be extended starting from 2014. The provided ice shelf and glacier front positions can be used to improve ice sheet models and sea-level-rise predictions.

